With respect to dependent Claim 9, which depends upon Claim 1, and Claim 17, the Examiner contends that the uniform distribution of pinholes in a predetermined pattern as described by the '688 Yin reference for the screen 22 may be considered to constitute a uniformly redundant array. The Examiner further contends that nevertheless, those of ordinary skill in the art would recognize that the use of a coded mask identified as a uniformly redundant array is known in the art of gamma ray imaging systems as shown by U.S. Patent No. 4,360,797 to Fenimore, et al.

Claims 10, 11, 22, 31 and 32 were rejected under 35 U.S.C. § 103 as being unpatentable over the '688 Yin reference in view of the Westrom, et al. reference and further in view of U.S. Patent No. 5,235,191 to Miller. The Examiner contends that the Miller reference discloses the use of a glass scintillator material for use as a position sensitive detector.

Claim 12 was rejected under 35 U.S.C. § 103 as being unpatentable over the '688 Yin reference in view of the Westrom, et al. and Miller references and further in view of U.S. Patent No. 5,308,986 to Walker. The Examiner contends that the Walker reference discloses the use of an external mural absorber coating in the construction of a fiber scintillator. Claim 13 was rejected under 35 U.S.C. § 103 as being unpatentable over the '688 Yin reference in view of the Westrom, et al. reference and further in view of the Walker reference.

Claim 33 was rejected under 35 U.S.C. § 103 as being unpatentable over the '688 Yin, Westrom, et al., Fenimore, et al. and Miller references and U.S. Patent No. 4,791,300 to Yin. The Examiner contends that it would have been obvious to one of ordinary skill in the art to modify the references to include the recited features in view of the improved performance. Lastly, Claim 34 was rejected under 35 U.S.C. § 103 as being unpatentable over the '688 Yin, Fenimore, et al., Miller and Westrom, et al. references. In his rejection, the Examiner again contends that the uniform distribution of pinholes in a predetermined pattern as disclosed in the

'688 Yin reference may be considered to constitute a uniformly redundant array. The Examiner further contends that nevertheless, those of ordinary skill in the art recognize that the use of a coded mask identified as a uniformly redundant array is known in the art of gamma ray imaging systems as shown by the Fenimore, et al. reference.

The '688 Yin reference discloses an instrument for obtaining quantitative, three-dimensional information relating to x-ray and gamma ray emitting objects. The instrument uses a multiple-pinhole aperture plate 22, which is spaced from an x-ray or gamma ray to visible-light converter 24, which is in turn coupled to a visible-light image intensifier 26. The spacing between the aperture plate and the converter is specifically chosen so that mini-images of an emitting object formed by the pinhole array do not substantially overlap as they impinge on the converter. The output of the image intensifier is digitized by a digitizing camera 36 in terms of position and intensity and fed into a digital computer 40. The computer is coupled to a suitable viewing device to provide an image of the object.

The Westrom, et al. reference has been cited by the Examiner as disclosing a radiation mapping system in which the system can be used to generate high resolution radiation dose maps superimposed on a real-time video image of a room or other area in a nuclear power plant or other facility using radioactive materials. The Westrom, et al. reference specifically uses a single pinhole screen and is capable of viewing only up to an 8° solid angle field of view. Both the '688 Yin and Westrom, et al. references were newly cited in the latest Office Action.

In response to the Office Action, Claims 1, 17, 19, 33 and 34 have been amended. Each of these claims now includes a specific recitation that the coded mask of the device comprises a uniformly redundant array having high throughput. Accordingly, each of the claims is directed to a gamma ray or x-ray imaging system for providing an image of a non-focusable radiation emitting source which includes a coded mask in the form of a uniformly redundant array having

high throughput, a position sensitive detector which generates a coded optical signal in response to a coded shadow formed by the uniformly redundant array, an array of charge coupled devices for generating a coded electrical signal in response to the coded optical signal, a signal processor for processing the coded electrical signal to generate an image signal therefrom and a display.

With respect to the '688 Yin reference, the device disclosed is a combination of a pinhole hole array, a scintillator and an imaging opto-electronic camera. This design would be recognized by those of ordinary skill in the art as a conventional, non-coded, image system wherein the field of view is limited by the field of view for each individual pinhole. More specifically, each pinhole images only a small portion of the object under observation. In order to image a large field of view, this system would require a large pinhole array practically equal in size with the object to be imaged. The system described in the '688 Yin reference specifically notes that the mini-images formed by each pinhole do not substantially overlap as they impinge on the converter. Otherwise, if overlapping occurred, the system would produce a blurred image of the radiation emitting object. This is a severe disadvantage of the system disclosed by the '688 Yin reference. Yet another disadvantage of the '688 Yin reference is that the spatial image resolution of the system described therein is equal to the size of the individual pinholes provided that the distance between the scintillator (phosphor screen) and the pinhole array is very small. The spatial image resolution of the system described in the present invention is significantly higher than that of the system disclosed in the '688 Yin reference due to the use of a high throughput uniformly redundant array as the coded mask.

Furthermore, the spatial image resolution of the present invention is enhanced with respect to the '688 Yin reference since the resolution is determined by the number of cells in the coded mask which has a high throughput as opposed to an array of pinholes having a very limited throughput. A further distinguishing feature of the present invention is the operation of the processors in each of the respective systems. With respect to the '688 Yin reference, the

processor performs an image rotation to correct image inversion introduced by the pinhole array. The signal processor of the present invention performs a completely different function in that it decodes the coded signal which is initially generated by the coded mask which is in the form of a uniformly redundant array. Accordingly, although the processor hardware of the '688 Yin system and the present invention appear somewhat similar, each operates in a significantly different way in order to produce an image on a display. It is also significant to note that the '688 Yin reference does not include any teaching or suggestion to modify the pinhole array in any way. Throughout the '688 Yin reference, the specific pinhole array in which the spacing between the aperture plate and the converter is chosen such that the mini-images of an emitting object formed by the pinholes do not substantially overlap as they impinge on the converter, appears to be a significant aspect of the device formed in accordance with the teachings in the reference. A significant difference between a pinhole array and the coded mask comprising a uniformly redundant array having high throughput is that the pinhole array has a very limited throughput and cannot achieve the resolution of a system utilizing a coded mask as defined in the claims of the present invention. In view of the foregoing remarks, Applicants respectfully request reconsideration of the rejection by the Examiner in which the Examiner considers the pinhole array as disclosed in the '688 Yin reference to constitute a coded mask in the form of a uniformly redundant array.

In the Office Action, the Examiner further rejects the use of a uniformly redundant array as being known in the art of gamma ray imaging systems as shown by the '780 Fenimore, et al. reference.

As discussed in the previous amendment filed on May 16, 1995, the essence of the Fenimore, et al. invention was the use of a uniformly redundant array to allow imaging of low-intensity sources and to eliminate artifacts. The system described in the Fenimore, et al. reference utilizes an Anger camera as the detector. The Anger camera detects emitted photons

from a gamma source and produces an X and Y position for the detected location of the emitted photons. The X and Y signal is converted to a digital position by an A to D convertor. This digital signal is then applied to a dual parameter pulse-height analyzer which increments the appropriate memory location. In this manner, the image projected on the detector is stored for subsequent processing. Once all of the data has been recorded in memory, the device includes a means to reconstruct an image of the emitting source on a display.

Although the Fenimore, et al. reference discloses an imaging system for non-focusable radiation, the system utilizes an Anger camera to generate the image. The imaging system of the present invention is significantly more compact and provides higher sensitivity over a wider dynamic range than commonly known Anger cameras. The present invention as defined in each of the independent claims provides a relatively simple, yet highly effective design for a gamma ray imaging system.

With respect to the Fenimore, et al. reference, the only imaging system suggested by this reference for use in combination with a uniformly redundant array is that of an Anger camera. There is no teaching or suggestion in the Fenimore, et al. reference to combine a coded mask comprising a uniformly redundant array with a state-of-the-art low-level imaging system as specifically defined in each of the independent claims including an array of charged coupled devices to convert the coded optical signal to a coded electrical signal.

In order to establish a prima facie obviousness rejection, there must be a basis in the art for combining or modifying the references cited by the Examiner.

> "Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984).

A careful review of the '688 Yin reference and the '780 Fenimore reference indicates that there is no teaching or suggestion in either of these references to combine a coded mask in the form of a uniformly redundant array with a portable radiation imaging system including a position sensitive detector, an array of charge coupled devices, a signal processor and a display as specifically defined in each of the independent claims, as now amended. In view of the absence of such a showing in the prior art, the claims are respectfully urged to be patentable over these references. Applicants respectfully note that it is impermissible for an Examiner to use the teaching in the present application to hunt through the prior art for the claimed elements and combine them as claimed. See In re Laskowsky, 871 F.2d 115, 117, 10 U.S.P.Q. 2d 1397, 1398 (Fed. Cir. 1989). Accordingly, Applicants respectfully urge that a combination of a uniformly redundant array to image non-focusable radiation and an imaging system including an array of charge coupled devices would not have been obvious to one of ordinary skill in the art at the time the invention was made in view of the teachings in the '688 Yin and '780 Fenimore, et al. references. Applicants respectfully request reconsideration of the rejections under 35 U.S.C. § 103 relating to the obviousness of the claimed invention, as a whole, in view of the reasons set forth above.

Dependent Claims 15 and 16, which depend upon and thus recite each of the limitations of Claim 1, specifically define a design parameter for the coded mask such that the field of view can range from about 1° to about 45°. The use of the coded mask including a uniformly redundant array having high throughput in the present invention modulates or codes a scene spatially and the system field of view is determined by the size of the coded aperture, size of the scintillator, and the distance between them. Accordingly, the combination of the uniformly redundant array with the scintillator provides a system which overcomes the distance dependent image blurring situation which can occur in a system using a pinhole array as described above with respect to the '688 Yin reference.

Moreover, dependent claims 15 and 16 are directed to a gamma ray imaging system in which the coded mask includes a cross-sectional area approximately two times the cross-sectional area of the position sensitive detector to provide for maximum field of view and wherein the field of view ranges from about 1° to about 45°, respectively. In the Office Action, each of these claims were rejected in view of the '688 Yin reference. The Examiner contends that the screen 22 of the gamma ray imaging system disclosed in the Yin reference is spaced from the position sensitive detector 24. The Examiner concludes that the choices of cross-sectional area and field of view are within the ordinary skill in the art in view of the intended application and the like. Applicants respectfully traverse this rejection.

With respect to the '688 Yin reference, the radiation imaging system requires that the spacing between the pinhole aperture and the radiation to visible-light converter be chosen such that the mini-images of an emitting object formed by the pinholes do not substantially overlap as they impinge on the converter. It can be concluded from this limitation that a mini-image which overlaps will produce a blurred image of the object. In the present invention, usage of a coded aperture comprising a uniformly redundant array will not have the disadvantage of requiring a specific distance between the aperture plate and the radiation to visible-light converter to avoid blurring of the object being imaged. Accordingly, the present invention provides an improved imaging system by maximizing the field of view able to the imaged by the system. Therefore, Claims 15 and 16 are respectfully urged to patentably distinguish over the '688 Yin reference for the reasons set forth above. Reconsideration of the rejections to these claims is respectfully requested.

Referring to Claim 33, a most preferred embodiment of the claimed invention is defined. More specifically, the gamma ray imaging system includes a coded mask comprising a uniformly redundant array, a glass fiber scintillator for converting the radiation into a coded optical signal, an optical fiber taper for transferring the optical signal to an image intensifier, a multistage image

intensifier for amplifying and intensifying the coded optical signal, an array of charge coupled devices for generating a coded electrical signal in response to the coded optical signal, a digital signal processor for converting the coded electrical signal into an image signal and a monitor for displaying the representative image signal thereon.

In the Office Action, Claim 33 was rejected under 35 U.S.C. § 103 as being unpatentable over a combination of five references. The Examiner concluded that it would have been obvious to one of ordinary skill in the art to modify each of the references to include the claimed features. Applicants respectfully request reconsideration of the rejection to Claim 33 since there is nothing in each of these references to suggest in any way the modification and/or combination of each of these five references in order to arrive at the claimed invention. More specifically, there is no teaching or suggestion in the '688 Yin reference to use any type of array other than a pinhole array. Furthermore, there is no teaching or suggestion in the Fenimore, et al. reference to use a uniformly redundant array with any radiation imaging system other than an Anger camera. Accordingly, there is no teaching or suggestion to combine the teachings of Fenimore, et al. to use a uniformly redundant array with those of the '688 Yin reference regarding use of a glass scintillator, an optical fiber taper, a multi-stage image intensifier tube, and an array of charge coupled devices. Each of the Miller, Westrom, et al. and '300 Yin references have been chosen by the Examiner in an effort to render obvious the specifically claimed combination in Claim 33. In view of the number of references required to arrive at the conclusion of obviousness by the Examiner, it is apparent that the invention defined in Claim 33 is not obvious in view of these five references. Reconsideration of the rejection to Claim 33 is respectfully requested.

The present invention overcomes many disadvantages of the known prior art. Usage and proper design choice of a uniformly redundant array, a high spatial resolution scintillator and a well-matched low level opto-electronic image assembly are the keys to constructing a compact and portable, highly sensitive gamma ray imaging system. The choices of using a glass fiber

scintillator as opposed to an ordinary crystal scintillator and the use of high spatial resolution optical imaging means over a traditional Anger camera provides significantly enhanced results by the gamma ray imaging system formed in accordance with the present invention. This design allows subdivision of each cell of a uniformly redundant array to improve the system sensitivity and image resolution. Accordingly, Applicants respectfully urge that the gamma ray imaging system of the present invention, which provides a large field of view and high sensitivity over a wide dynamic range to provide a real-time image, patentably distinguishes over the references of record, either alone or in combination.

In view of the foregoing amendments and remarks, entry and favorable consideration of the amendments to Claims 1, 17, 19, 33 and 34, favorable reconsideration of Claims 4-7, 10-16, 20-22 and 31-32 and allowance of the application with Claims 1, 4-7, 10-17, 19-22 and 31-34 are respectfully solicited.

Respectfully submitted,

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